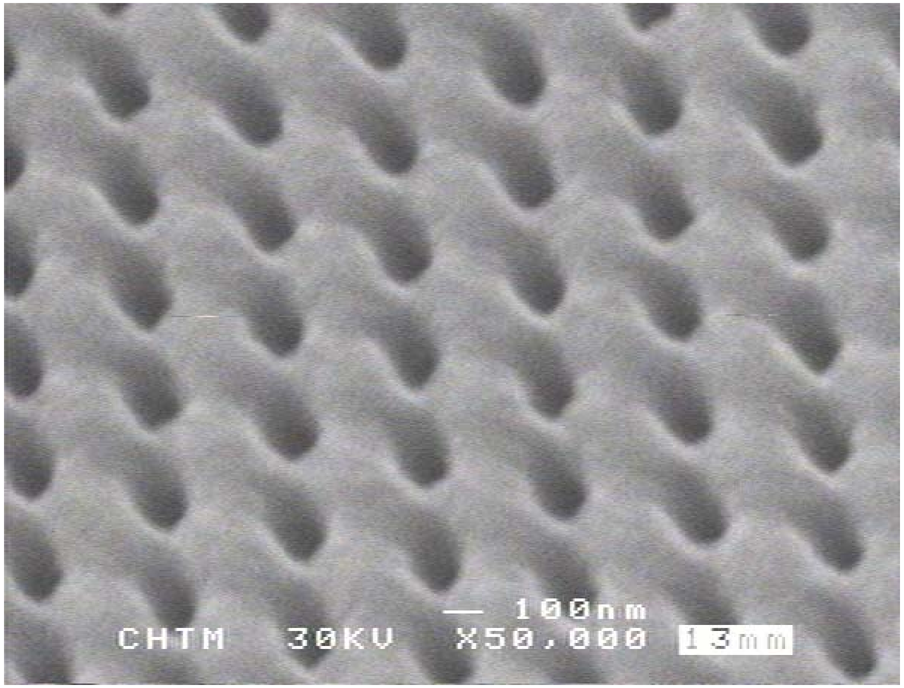
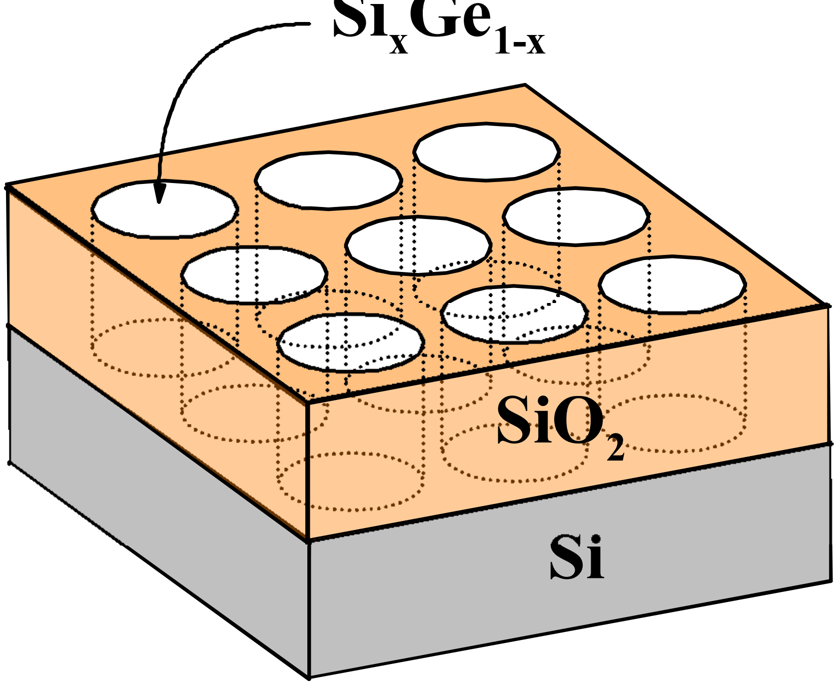
Selective Growth of SiGe Through Nanoscale Vias in SiO_2 Template





Materials Science & Engineering for Nanostructure Integration; S. M. Han *et al*. at UNM; DMR-0094145. Integrating nanostructures for working devices requires precise control on size and position. Prof. Han's group intends to address some of the integration issues by surface engineering. The group is currently exploring 3 possible paths to grow SiGe nanostructures at pre-determined locations: (1) selective growth through a nano-patterned template, (2) stress-induced growth in nanometer scale recesses, and (3) preferential growth on select crystallographic planes. The scanning electron microscope picture demonstrates the 1st approach. Cylindrical vias whose diameter is approximately 50 nm are patterned on a SiO_2 film using interferometric lithography and plasma etching. The group intends to probe and engineer the chemical and physical nature of the exposed surface and SiGe precursors for selectively growing SiGe on Si rather than on SiO_2. The potential applications of Ge and SiGe nanostructures on Si are quantum computing systems and light-emitting quantum devices, respectively. For the quantum bit (i.e., qubit) computing systems, one can exploit charge coupling, electron spin coupling, and magnetic spin coupling between interlayer Ge quantum dots. Figure 1(a) conceptually shows an example of such quantum devices where Ge dots are embedded in Si and vertically stacked in two tiers. For the light-emitting devices, SiGe can be epitaxially grown on top of nanometer scale Si islands. Figure 1(b) shows a simplified cross-sectional view of SiGe columns grown on top of Si islands. The relative length of SiGe columns to that of Si islands can be tailored.

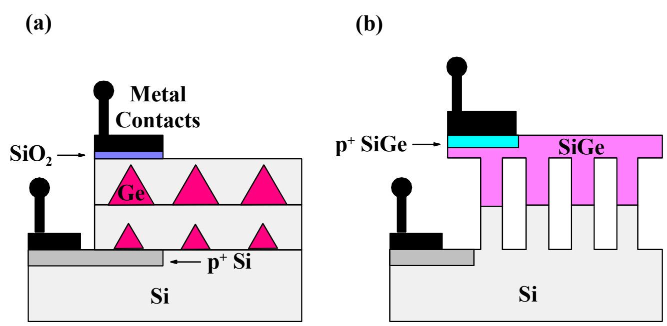


Figure 1: *Conceptual architecture of (a) qubit quantum computing system and (b) light-emitting quantum structure based on Si and Ge.*

Close Mentorship and Career Counseling Through Materials Science Research

Prof. Sang M. Han's research group at the University of New Mexico (UNM) utilizes the support from NSF (DMR - 0094145) to provide close mentorship and career counseling for both graduate and undergraduate students. The research education, when combined with personal guidance, expedites the students' scientific maturity and successful career development. Among the undergraduate students who took advantage of the research opportunities are Dawn Ramirez pursuing intellectual property management in Washington DC, ToniLisa Arviso-Jeans applying for a MS program in electrical engineering at UNM, Sacha De'Angeli attending UC Berkeley for a PhD in chemical engineering, and Angela Zivkovich continuing her research experience at the Sandia National Laboratories. The NSF Research Experience for Undergraduates (REU) Program through the Center for Micro-Engineered Materials at UNM concurrently supports such undergraduate participation. Roya Ahmadian is the latest group member who is continuing the legacy. The NSF support foremost extends to graduate students. Qiming Li is the group's 1st PhD student studying selective growth of nanometer-scale SiGe structures through a patterned oxide template. The project exemplifies group's intent to educate future scientists and engineers who can resolve some of the integration issues of nanotechnology.